REMARKS

In response to the outstanding Office Action, applicant has amended the specification to eliminate references to "this patent" and to correct a number of minor grammatical or typographical errors and omissions. In addition, an explanation of certain terminology in the specification, which apparently has led to a misunderstanding of a feature of the invention, has been added to paragraph [0002]. Claims 79 – 82, 85, 89, 92, 93, 95 and 96 have been amended to put them in condition for allowance; previously withdrawn claims 83, 91, 97, 101-103 and 105 have been amended to be dependent on claim 79, and now should be considered allowable with claim 79 and thus eligible for rejoinder; and previously withdrawn claims 84, 99, 100, 104 and 106 are now dependent on claims that are, in turn, dependent on claim 79, and should now also be considered allowable and eligible for rejoinder. Claims 107 – 111 remain withdrawn. Favorable reconsideration and allowance of the claims now in the application is solicited.

As was pointed out in the Preliminary Amendment filed in the application in September 2005, the present application is directed to a process for monitoring the progress of the fabrication of an optical fiber or of a lens on a fiber to ensure that the final product will exhibit the desired light-emitting characteristics. As is known, if the shape of the fiber or lens is not correct, the light emitting characteristics will not be correct, so the present invention provides a method for improving the speed and accuracy of known fabrication processes by first producing a "theoretical simulation" that defines, or specifies, the desired characteristics, or parameters, of the structure that is to be fabricated. As the structure is being fabricated, it is monitored ("characterized") to detect the current geometric and optical characteristics, and these measured characteristics are compared with the original simulation to track the progress of the fabrication, and the process is adjusted as needed to ensure that the final product meets the desired specifications. This is an iterative process, in the nature of a conventional feedback system.

A key to the present invention is that the characteristics of the structure being fabricated are monitored by "near-field" and "far-field" techniques. The near-field measurements monitor optical parameters such as light intensity, polarization, phase properties, spot size, mode field diameter, waist diameter, and the like, for emitted light, while far-field techniques measure the geometry, topography, and like characteristics of the structure. These measurements are integrated and used to compare the current characteristics of the structure, as it is being fabricated, with the predetermined desired specifications of the device, so that the fabrication

process can be controlled. Such integrated near- and far- field measurements can also be used to characterize a lens or other optical structure after the fabrication process has been completed. See paragraphs [0036] – [0046] of the specification for a more detailed explanation of this process, and for examples of how it is done. See also Figures 1 – 4 and their descriptions for an illustration of the process for simulating a desired device.

As described in the specification, techniques such as atomic force microscopy are used to measure topographic features of an optical waveguide device such as a lens, including, for example, its radius of curvature, its cone angle, the taper of a fiber, and like geometric features. In the Office Action, confusion was expressed about the concept of "atomic force" in the measurement of very small (micro- and nano- dimensioned) structures. However, it should be pointed out that atomic force microscopy is a well-known and well-established procedure, and not only were atomic force microscopes commercially available at the time of this invention, but the literature abounded in articles on the subject. (See the on-line encyclopedia "Wikipedia" under "Atomic Force Microscopy.") In addition, the US Patent Office has issued numerous patents in this field – some to the present applicant.

Also as described in the specification, near-field optics are used, in accordance with this invention, to measure parameters such as the light distribution in a lens; i.e. the direction in which rays of light leave a lens formed on an optical waveguide, and the phase characteristics of that light. Again, the measurement of light in the near field was a known technique at the time of this invention, and is described in the specification, as well as in prior patents issued to the present applicant.

In accordance with the invention, the near-field and the far-field measurements are combined, or integrated, in, for example, a microscope, as described in the specification, and the integrated information about the measured parameters characterizes the device being measured. As already noted, this integrated information is iteratively, or repetitively, fed back for comparison with the original simulation and control of the fabrication process.

The Office Action characterizes the present invention as being "extremely complex in nature," and supports this contention with an assertion that the concept of atomic force measurement cannot be understood, and that accordingly the invention somehow relates to "a theorized fifth fundamental force of the universe." Applicant is at a loss how to respond to this objection to the present application other than to point out that in fact, the invention is quite

simple: as pointed out in numerous places in the specification, and as outlined above, the fundamental feature of the invention is the use of both near-field and far-field measurements to control the fabrication of an optical device such as a waveguide having a light-emitting lens. The use of these two measurements for this purpose had not been done before applicant's invention.

Perhaps the source of the misunderstanding of this application lies in a misconstruction of the term "theoretical simulation" as it is used in both the specification and the claims. In contrast to the unsubstantiated assertions in the Office Action that this term has reference to "a theory related to creatures from outer space," applicant respectfully submits that a reading of the description at paragraphs [0036] through [0046], as well as other places throughout the specification, will quell any fears about Applicants' seeking to claim such creatures. For example, paragraph [0036] discusses applicants' "new theoretical understanding of the parameters that are important in fiber optical element, including fiber lens, production." Paragraph [0037] points out that this theory is based on "an exact numerical field calculation . . . guided by constraints that are imposed by near-field optical characterization of the resulting elements." Paragraph [0037] points out ("In one emulation of our method") that to carry this out, a "geometrical model" of the device is devised, and in paragraph [0038] it is said that the use of the near-field model is "critical in fiber lens simulations." Paragraph [0039] describes the use of the Helmholtz wave equation with near-field boundary conditions that are defined and adjusted using an iterative procedure, "so that exact replication of simulation and results were obtained." As pointed out there, "this iteration and adjustment is novel." It is clear, then, that the "theory" discussed in the specification is that near-field measurements can be used to define, characterize and control the fabrication of an optical waveguide. As pointed out in paragraph [0045], "near-field optical measurements allow us to practically confirm the theoretical predictions", as illustrated in Figure 4. Furthermore, as pointed out in paragraph [0049], the invention incorporates such near-field measurements with known far-field measurements to provide an integrated characterization tool that allows highly accurate geometric and light profiling of micro- and/or nano- optical structures at the surface, in the near-field or at far-field distances above the structure with little contribution from out-of-focus light so that the phase properties of the wavefront can accurately be characterized in a way that is totally integrated with atomic force topographic and scanned probe methods (SPM) for micro- and or nano-scopic characterization.

In order to make it abundantly clear that the present invention is directed to the concepts described throughout the specification, applicants have amended paragraph [0002] of the specification to include the following language:

> "As used in this application, a theoretical simulation of an optical device that is to be fabricated is a mathematical model ("simulation") of the desired ("theoretical") structure of the device and of the optical fields within and outside the device. As described below in paragraph [0039], the model may be based on the well-known Helmholtz wave equation. Near and far field measurements of the characteristics and parameters of the device as it is being fabricated and iterative recalculation of the model provide accurate monitoring of the process."

This terminology is taken from the specification, as discussed above, and adds no new matter; it is merely for clarification of terminology that has apparently been susceptible to misinterpretation.

Turning now to a detailed consideration of the Office Action, in the order of the objections and rejections made, Applicant notes that the specification has been carefully reviewed to eliminate the informalities noted in the Action, as well as other informalities discovered during that review. The references to "this patent" have been changed to "this application" or "this invention," as appropriate.

35 USC 112, First Paragraph

Claims 79-82, 85-90, and 92-96 have been rejected under 35 USC 112, first paragraph, as "failing to comply with the enablement requirement," it being asserted that the subject matter claimed is not described in the specification in such a way as to enable one . . . to make and use the invention.

Applicants will respond to the lettered paragraphs in the Office Action in the same order:

(A) The Office Action objects to the term "theoretical simulation" as being "rather broad." This issue has been dealt with above. The claims have been amended to eliminate this term, and now recite the use of a mathematical model. This terminology and usage is clearly supported in the application as filed, as already discussed.

(B) The assertion concerning the alleged complexity of the invention has already been discussed. Furthermore, the specification clearly supports the claims in this regard.

(C) Applicant presumes that the statement that "the prior art is much below the present invention" is an indication that the prior art does not teach or suggest the invention, and agrees with this.

(D) The assertion that "one of ordinary skill generally has little/no experience in new theories or atomic forces" is believed to be incorrect. New theories of operation for devices or methods are the bread and butter of researchers in the sciences, and, as pointed out above, atomic forces are well known.

(E) This comment is not believed to require a response.

(F) Applicant's "new theory" is clearly and specifically spelled out in the specification, as discussed above. The theory relates to the use of integrated near and far field measurements in controlling the fabrication of optical waveguides and lenses, and the actual physical fabrication, that the Office Action admits is present in the application, is clearly labeled as an "emulation" or embodiment of the theory.

(G) Contrary to the assertion in this paragraph of the Office Action, there are, of course, working examples of the theory of the present invention, as admitted by the Office Action in the first sentence of section (F).

(H) The assertion that the application is directed to "any theoretical simulation," even those "outside generally accepted theories and laws of science" is believed to be contrary to the clear teachings of the disclosure.

It is respectfully submitted that the Examiner's conclusions are without substance and are not supportable by the facts. There is nothing in either the specification or the claims that would require a person of ordinary skill in this art to create and use a new theory. To the contrary, the specification is quite clear in setting out in great detail what applicant's "theory" is: it is the new and novel idea of integrating near and far field measurements of a fiber lens to control the fabrication of the lens so that it meets predetermined specifications. The Office Action asserts that 'the claims are of a scope that encompass any theory," and asserts that "inventors *generally* cannot get patent protection based on theories that are not yet made" (emphasis added), but that assertion confuses breadth with enablement. Furthermore, the theory being claimed has been made.

The Office Action asserts that there are other aspects that appear to be lacking in enablement, and asserts that "nanoindentation is used to measure strength/hardness of materials." In this regard, it is requested that paragraphs [0076] and [0077] of the application be reviewed. As there described, nanoindentation is a process for forming an aperture in a metal deposition on a fiber, and no experimentation is needed to accomplish the described operation. With respect to

the asserted lack of guidance about the size or shape of the lens, Applicants merely point out that the present invention is directed to micro- and nano- dimensioned devices, and that, of course, is the size of the lens being fabricated.

In summary, Applicants respectfully submit that the foregoing rejection based on 35 USC 112, first paragraph, is without merit and cannot be sustained.

35 USC 112, Second Paragraph

The claims listed above have also been rejected under 35 USC 112, second paragraph, as "being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention."

In response to the question about the terms "micro" and "submicro" it is, of course, true that these terms are often used as prefixes, and it is clear not only from context but from many cases of explicit usage in the present application, these terms are prefixes. Unfortunately, the hyphens ("-") indicating such usage were omitted in some cases. This has been corrected in both the specification and in the claims. The same is true for the term "nano." It is submitted that the claims are now clear and unambiguous.

In response to the objection to the term "and/or," it is respectfully submitted that the asserted lack of clarity is without basis. According to the "Oxford Universal Dictionary", 3rd Edition Revised (1955), "and/or" is defined as follows: "formula denoting that the items joined by it are to be taken either together or as alternatives." The American Heritage Dictionary of the English Language" (1969) defines "and/or" as follows: "Used to indicate that either *and* or *or* may be used to connect words, phrases, or clauses depending on what meaning is intended. Usage: *And/or* is principally appropriate to legal or commercial usage. It is most useful in setting forth three distinct and exclusive possibilities: either of two things considered separately or the two in combination (that is, one or the other or both)." Accordingly, it is submitted that the usage of this term in the present application is both grammatically appropriate and accurate.

The comments concerning antecedents are noted, and have been corrected by amendment.

The comment concerning the use of the term "predicting" is not understood. It is clear from what has been said above, and from the context of usage in the application, that the use of a mathematical model to predict the ultimate shape of a product manufactured under the control of the model is a well-know procedure.

The comments concerning the asserted indefiniteness of claims 80, 82, 85 – 88, 92, 93 and 96 have been attended to in the claim amendments. It is noted, however, that claim 85 does not imply that claim 79 requires a protrusion; to the contrary, claim 85 makes it clear that claim 79 is not so limited. It should also be observed that the fact that claims such as 85 and 86 encompass alternatives is an indication of breadth, not indefiniteness. With respect to claim 88, it should be noted that the referenced "protrusion" may be formed using the well-know process of pulling a heated fiber to the breaking point. Thus the protrusion is part of the fiber, and a lens formed on the protrusion is also formed on the fiber. The examiner observes, rightly, that the claim indicates that one can coat the lens without coating the fiber (or vice-versa), but questions the use of the term "selectively coating." To use the Examiner's example, this is like saying that one can paint a barn without painting its windows, and that selection is certainly an understandable concept. It is believed that the claim is clear and definite. Selective coating certainly involves a choice at some point, and choices are an essential part of every fabrication process, but the existence of choice does not exclude automation of a process.

With respect to the comment concerning the taper angle of claim 81, the claim has been amended to eliminate the term "working distance." In this regard it is noted that the line 1.4 in Fig. 1 denotes the surface of the structure which forms an angle with the axis of the structure; thus this line defines the "taper angle."

In summary, the claims as now presented are believed to be clear and definite, and in condition for allowance.

35 USC 102(b)

In the Office Action, claims 79-82, 85-87, and 94 have been rejected under 35 USC 102 as being anticipated by Shiraishi 5446816.

Applicant respectfully traverses this ground of rejection for the reason that the reference neither describes nor suggests the method of fabrication set out in the claims of the present application. Shiraishi describes at Col. 7, lines 29 – 52 two methods of forming a lens on a fiber: (1) the use of a die having a concave face against which a heated fiber is pressed, and (2) the use of a sleeve having a convex surface, with a small-diameter hole for receiving the end of the optical fiber. No claim of the present application can be read in any way that would lead to the conclusion that it is directed to either of these methods. Although the reference describes a

process of mathematically modeling a desired shape, which applicants also use, that is the end of the similarity between the reference and the herein-claimed invention.

As discussed in detail above, each of the claims of the present invention is directed to a method of fabricating a structure in which a desired structure is modeled, and then during the fabrication process, the parameters of the structure are monitored by both near-field and far-field procedures, and the monitored characteristics are iteratively fed back for comparison with the original model. There is no suggestion of this procedure in the reference, and accordingly the rejection under 35 USC 102 must fail.

For example, Claim 79 recites, among other things "characterizing the emitting surface of the structure by near-field and by far-field geometric and light profiling" and no such step is either described or suggested in the reference. The remaining claims under consideration are all dependent on claim 79 and include the same distinguishing feature. Accordingly, it is evident that the claims in the application are not properly rejectable as being "anticipated" by Shiraishi et al.

Claim 79 has been further rejected under 35 USC 102(b) as being anticipated by Lewis WO 00/34810, under the same reasoning used with respect to the rejection based on Shiraishi.

Under the same reasoning discussed above, the Lewis reference cannot "anticipate" claim 79, for the reference does not disclose or even suggest the claimed method. Lewis is directed to a method of forming a lens, but there the similarity ends, and that similarity cannot support a rejection under 35 USC 102(b). Nowhere does the reference disclose the use of near- and far-field techniques in combination ("integrated") to measure a structure during fabrication, along with iterative comparison with a model. Accordingly, this rejection cannot be sustained.

Claims 79 and 94-96 have been rejected under 35 USC 102(b) as anticipated by Sharp 48767776 (sic), under the same reasoning given for the rejection based on Shiraishi.

Under the same reasoning discussed above, the Sharp (US Patent No. 4,867,776) reference cannot "anticipate" claim 79, for the reference does not disclose or even suggest the claimed method. Sharp discloses a computer-controlled centrifuge having a "closed loop" embodiment wherein light transmitted through a fiber being fabricated is reflected and returned along the fiber, and "analyzed to allow determination of the shape formed on the fiber." But there is no teaching in the reference that such analysis should, or even could, be done by

integrated and iterative near- and far- field measurements. Accordingly, the reference cannot "anticipate" the herein claimed invention.

35 USC 103(a)

Claim 88 has been rejected under 35 USC 103(a) as being unpatentable over Shiraishi 5446816 on the ground that it would have been obvious to use a coated fiber in Shiraishi, and further obvious to remove the coating prior to melting and to thereafter recoat it.

As noted above, Shiraishi does not include the basic features of claim 79, on which claim 88 is dependent; therefore, the reference cannot make obvious the combination of features set out in claim 88.

35 USC 102(b)

Claims 88 – 90 have been rejected under 35 USC 102(b) as being anticipated by Lewis WO 00/34810.

Since claims 88 – 90 are dependent on claim 79, it is submitted that this rejection is redundant to the rejection of claim 79 on the same grounds. Applicants' response is the same: the reference fails to teach the feature in claim 79 of near- and far- field monitoring of a structure being fabricated; therefore it cannot teach the same features of dependent claims 88 - 90.

Under this rejection of claims 88 – 90, the Office Action discusses features of claims 92 and 93. No response is believed required, since these claims were not rejected on this basis.

Conclusion

In view of foregoing amendments to the specification, the careful revision of the claims, and the foregoing extensive remarks, it is evident that applicant has made an earnest effort to respond to each issue raised in the very detailed Office Action. It is believed that the claims are now free of ambiguity, are clear and definite, and clearly define patentable subject matter over the references relied on in the Action. Favorable reconsideration and allowance of the application are, therefore, respectfully requested.

Respectfully Submitted,

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